Virtual Reality Challenges in Education and Training

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***Abstract*—Virtual Reality (VR) will soon be something millions of people will be using. It will expand into a broad spectrum of our current world. VR is a technology that enables the creation of computer generated virtual worlds with which the user can interact and immerse in. VR gear and content will be the next hype word and it is estimated their market will be worth more than $70 billion by 2020. In fact 2016 is considered to be the year of Virtual Reality. One of the fields that can take an evolutionary advantage of VR is education and training due to the great interactivity level that VR allows the users to experiment the concepts he is taught with. The paper aims at performing a brief analysis of current VR challenges, and especially its application in education and training.**

***Index Terms*—education, training, digital content, virtual reality**

I. Introduction

Virtual Reality (VR), which can be described as immersive multimedia or computer-simulated reality, replicates an environment that simulates a physical presence in places in the real world or an imagined world, allowing the user to interact in that world [1]. VR has a long history – its technical foundations could be traced back to the early 1950s, even though it has been a concept long ago conceived [2].

Michael R. Heim in his famous book *he Metaphysics of Virtual Reality* has identified seven different concepts of VR - simulation, interaction, artificiality, immersion, telepresence, full-body immersion, and network communication [3], [4]. The human body has major senses which allow it to gather information about the world surrounding it., such as sight, hearing, touch, smell taste, pain, balance, movement, etc. The senses receive information from outside and inside the body. This information must then be interpreted by the human brain. The process of receiving information via the senses and then interpreting the information via the brain is known as perception. When creating a virtual world, it is important to be able to emulate the human perception process or in other words the key to VR is trying to trick or deceive the human perceptual system into believing they are part of the virtual world. Thus a perfect feeling of immersion in a virtual world means that the major senses have to be stimulated, including of course an awareness of where we are within the virtual world. To do this, we need to substitute the real information received by these senses with artificially generated information. In this manner, we can replace the real world with the virtual one. The impression of being present in this virtual world is called virtual reality.

A variety of technologies are used to create this illusion nowadays, including [5]:

- Stereoscopic Displays**.** Also known as *3D displays*, or *head mounted displays* (HMDs). These displays use a combination of multiple images, realistic optical distortion, and special lenses to produce a stereo image that our eyes interpret as having three-dimensional depth.
- Motion Tracking Hardware. Gyroscopes, accelerometers and other low-cost components are used in virtual reality hardware to sense when our bodies move and our heads turn, so that the application can update our view into the 3D scene.
- Input Devices. Virtual reality is creating the need for new types of input devices beyond the keyboard and mouse, including game controllers and hand- and body-tracking sensors that can recognize motion and gestures.
- Desktop and Mobile Platforms. This includes the computer hardware, operating systems, software to interface to the devices, frameworks and engines that run applications, and software tools for building them.

Without all four of the above components, it is hard to achieve a fully immersive virtual reality experience.

Hence, we can conclude that in general VR is the computer-generated simulation of a 3D environment, which seems very real to the person experiencing it, using special electronic equipment.

The objective is to achieve a strong sense of being present in the virtual environment [6].

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II. Current State of Virtual Reality

VR is a hype word today and it is not a surprise that 2016 is considered to be the year of Virtual Reality. With final production versions of VR hardware and software being readied for market launch, it is now clear that the market is rapidly approaching to a point in which VR technologies reach a critical mass of functionality, reliability, ease-of-use, affordability and availability [6].

VR headsets and VR-capable hardware and software will be readily available to the public in 2016, and people will begin to experience VR and explore its near-endless potential. Virtual-reality device sales will hit 14 million units worldwide in 2016, providing a strong launch point for the category. The sales will rise to 18 million units in 2017 and 22 million by the end of 2018. In 2020, sales could reach 38 million units worldwide [7].

In 2016 various companies will be offering significant volumes of high quality equipment at consumer level prices and there are lots of existing companies and start-ups working on products to take advantage of this [8]:

- The Facebook-owned venture, *Oculus Rift*, represents the most anticipated device for VR enthusiasts. After much speculation and waiting, Facebook finally announced this summer that the X-Box-compatible headset will come out during the first quarter of 2016. The Rift delivers on the dream of consumer VR with compelling content, a full ecosystem, and a fully-integrated hardware/software tech stack designed specifically for virtual reality [9].
- Google Cardboard, is literally a cardboard cutout that folds into a headset and uses your cellphone as a screen. It's compatible with most Android phones, and Google is encouraging developers to release apps using the technology. Google 360 allows viewers to have a VR experience of Google Maps [10].
- Sony is developing its own VR headset, formerly known only as *Project Morpheus*, and recently revealed under the name *PS VR*. The headset will be compatible with Play Station, and is also due to be released in the first half of 2016. With high definition graphics, ultra-sensitive motion detectors, and integrated sound systems, the technology will likely also usher in its own set of dedicated 3D VR games [11].
- The HTC VR headset, named Vive, was developed in conjunction with Valve, creators of such ground-breaking games as Portal and Half-Life. HTC manufactures some of the finest consumer electronics on the planet and Valve is an unrivaled architect of virtual worlds, so you know the collaboration is something special. Vive is powered by Valve's SteamVR so plenty of games that take advantage of its capabilities will soon be available on the Steam service [12].
- Samsung Gear VR works seamlessly with Galaxy smartphones. All you need to do is slip in your phone and you're free to take on the world and beyond. A Super AMOLED display, wide field of view, precise head-tracking and low latency brings reality to the virtual [13].

Results from the fourth annual Game Developers Conference State of the Industry Survey among more than 2,000 game developers has revealed that development of virtual reality titles has more than doubled among participating developers and that 16 percent of developers are currently creating titles for VR, up from the 7 percent of developers who replied in the affirmative in last year's survey. Projecting further into the future, 15 percent of participating developers have affirmed that their next game will incorporate VR, up from the 6 percent who affirmed their VR ambitions last year [14].

The modern VR environment is not only hardware devices. It is also the software needed for creating VR content. It is quite natural the major manufactures of VR hardware do develop their own tools for content creation. Oculus Rift, Google Cardboard, HTC, Sony, Samsung are typical examples for the provision of highly specialized custom software for building virtual worlds and reality. On the other hand the number of third-party companies offering VR development software is on the rise.

It is a logic question to define the most advantageous areas in which the investment should be made based on VR technology. The following classifications have already been done [15]–[20]:

- Gaming - VR has already made a significant success and it is considered so far the main driving force behind the VR technologies;
- Entertainment - VR creates by Movies, TV and music an immersive experience where the default state is belief, creating deep emotional responses from viewers;
- Travel and leisure – VR travelers will immerse themselves in different hotels, taking in all the amenities, meeting spaces, sights and sounds, long before their actual arrival to the real place.
- Advertising and marketing - VR will give advertisers the opportunity to go beyond 2D video and TV commercials to create unique consumer experiences around their products or brand;
- Enterprise collaboration and videoconferencing - VR will make collaboration between remote employees seem to take place in the same room, allowing teams to be more productive and cohesive.
- Education - even the best online education systems, in which students can watch video lessons and interact with professors and other students via text or video chat, cannot compensate the feeling being in a real classroom.

These five top sectors are being followed by the VR penetration in engineering, design, real estate, travel, finance, conferences, healthcare, recruiting, etc.

III. Virtual Reality in Education and Training

Education and technology are interconnected. Education has not changed in time in terms of teaching

approaches and techniques applied. Students today feel comfortable with online education, doing research on the Internet, resorting to instructional videos on YouTube, sharing content on social networks.

One of the most rapidly mutating forms of online and computer-based learning is "immersive environments" [21]. An immersive environment allows learners to be totally immersed in a self-contained artificial or simulated environment while experiencing it as real. Immersive environments can offer learners rich and complex content-based learning while also helping learners hone their technical, creative, and problem-solving skills. Because immersive environments are so rich and visual, users tend to be highly engaged. There are several types of immersive environments: virtual worlds, web-based video games, massively multiplayer online games, multi-user virtual environments, simulations, augmented reality.

Virtual reality is next with its ability to introduce practical knowledge to the classroom without actually leaving it, makes educational experience invaluable. VR can augment traditional education through simulations and virtual experiences. Many potential benefits of introducing VR in education and training have been already identified [22]-[26]:

- Virtual platforms and headsets are the new tools for inspiring creative learning;
- Education which is not possible in reality, will be possible in virtual reality;
- Virtual game-based experience increases students' motivation;
- Collaboration in virtual reality classroom fosters social integration of learners;
- Learning is achieved by direct interaction, not by mouse clicks;
- The results from the learning process are truly assessed.

A lot of educational organizations and institutions are already taking advantage of VR technology for marketing purposes. A vast majority of top institutions are using it to recruit prospective students in a variety of ways. VR reality is the perfect tool for student recruitment since it allows colleges to effectively reach, engage, and appeal to prospective students through virtual campus tours [27]. Now universities offer options for distance learners to take offline and online classes; soon, colleges will use VR technology to achieve a full student immersion in the college experience, allowing them to feel present in a classroom discussion or lecture. Universities can also record these experiences for later use or use live-streaming virtual reality. VR also offers schools the chance to immerse students in important cultural events. VR could allow students to virtually attend sports games or participate in virtual networking events for past and present students to meet and discuss their experience and achievements at a particular university.

VR can be used as a fully immersive experience in classrooms. This involves equipment like a head-mounted display and data gloves for interaction with a virtual environment. This allows the student to attend a virtual lecture theatre or seminar room, hence replicating the experience of being in a physical space. VR could be used to facilitate staff development of offshore academic staff - an activity that requires significant human and financial resources. Similarly, it could be used to facilitate international academic boards, validation and events and aid quality assurance reviews processes [28].

Entering a simulated VR environment encourages students try new approaches which help them advance in their learning and experience. It is not necessary all of them to be successful. However, each scenario could be started over and over and it is quite different from test-driven classroom work, where failure remains on student academic record. VR world gives freedom to the learners to experiment, which can lead to better solutions to real-world problems [29]:

VR can successfully be used for educating students in:

- Architecture and civil engineering;
- Chemistry;
- Machine engineering;
- Medicine and Biology;
- Physics and Astronomy;
- Business;
- Entertainment;
- Fashion;
- Media;
- Military;
- Scientific Visualization;
- Sports;
- Telecommunications, etc.

Virtual Reality is exceptionally useful for professional training, since VR allows people from different professions to prepare for their roles in an environment that is removed from potential dangers and tin this way it is becoming an important training tool for a range of areas [30]:

- Healthcare is one such area that is benefitting greatly from VR since doctors and dentists are able to train for a variety of scenarios without the pressure involved in a live surgical procedure;
- Training drivers and pilots can greatly benefit from VR regarding not only from effectively measuring their reactions, but also making substantial cost reductions related to different type of machinery and accompanying technical support.
- The need for disaster management training is expected to grow over the next decade, mostly due to the effects of global warming. With glaciers melting, sea levels rising, cloud forests drying and ravaging storms, it is never been more important for institutions to be prepared for the worst. Disaster risk reduction and emergency specialists can obtain an invaluable experience from VR environments in which different disaster scenarios could be simulated and the personnel could be trained to respond to critical situations with confidence. A virtual reality simulation of emergency preparedness could provide more varied scenarios and help avoid the hasty, panic-

driven thinking which can lead to unnecessary accidents and deaths [31].

- Interactive VR-based disaster training can be tailored to specific users as well as organizations, based on their resources and hazard vulnerability analysis. VR-based scenarios can be developed for instructional task-focused training in which the program responds to user inputs and provides instant feedback. VR-based exercises can also allow an organization to test its emergency response plans in order to assess its effectiveness, and in turn identify gaps and areas for improvement. VR-based applications can also facilitate consistent and repeated training over geographical and organizational divides [31].
- VR applications can be applied individually or to groups allowing participants do work on their own or interact with other users. The VR environment can replicate any real world settings such as different landscapes, mountains, water resources, buildings, vegetation, winds, complex natural events, sounds, etc. From a cost perspective, VR-based disaster training has significant advantages. From relatively simple table-top exercises where participants convene in a conference setting for discussion, to more complex full scale exercises where personnel and equipment are mobilized, real-life drills and exercises are expensive in both time and resources required [32]-[34].

Despite these promises, VR is still not perfect from a technological, organizational and psychological point of view since it suffers from a numbers of weaknesses:

- VR is often considered as a game, which is not taken very much seriously – it is fun to play with, but not a real learning process. Students can show attitude which assists for winning the game, but not fully engage their mind to acquire new knowledge and critical thinking.
- VR require intensive graphics capabilities that are not at all times possible with standard computer equipment and it could take significant efforts to achieve smooth implementation and worth immersion and interaction.
- VR is often delivered as propriety solutions that could not be matched with similar environments from other developers–many companies offer their own tools to create VR environments that are not compatible with the rest regarding hardware and software.
- VR is not suitable for students from different cultures, religions, ethical groups and geographical regions–this is a serious consideration, which could significantly limit the successful distribution and adoption of even already proved implementations.
- VR is different to males and females due to their specific psychological level of world perception and behavior–they react and respond differently to situations and events.
- VR is not suitable for students and teachers that are not in similar gender groups – often older educators do not feel comfortably with the digitalized younger generation. Older educators are more reluctant to newer forms of education, but it is only problem of time when both students and teachers will have one and the same digitalized background.
- VR, after its initial adoption as a new technology, will require unified standards for the preparation of professional curriculums that are compatible between different educational institutions regarding content preparation, implementation and educational result achievement.
- VR training time - depending on the size of the organization, cultural characteristics of the workforce and the existing used methodologies, training time could be minimal or extensive.
- VR training could provide participants with a higher level of realism and immersion in comparison to classroom instructions and web-based educational material. However, VR scenarios still lack the direct hands-on experience and face-to-face interactions that real-life exercises provide. The novelty of VR requires a preliminary training with such environments to enable users effectively use new systems.

IV. Conclusion

The popularity of VR applications and services will grow in the next years to come and industry will begin to find new ways to take full advantage of the technology. For colleges and universities VR technology creates immense opportunities - from student recruitment to the real learning processes.

VR will require professional skills for content generation, full immersion, interaction, programming and implementation. Hence new generation of VR specialists - graphic designers, programmers and engineers must be educated first for delivering solutions that are not only technically perfect, but which will take into account all mentioned in this paper shortcomings of today's concept of applying VR in education and training.

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